International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-3, January 2020

Design and Development of Efficient Water Management for Agriculture using IoT and Fuzzy Logic

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***Abstract*: Agriculture is a major source of living in India. The productive growth of the crop depends mainly on various sources such as adequate supply of water, fertilizers and soil conditions. Excessive water in the farming field may damage the crop and similarly limited supply of water results for causing diseases in crops. Therefore the proper management of water is required for better yield of the crops. In this paper, a system was designed and developed for efficient water management in agriculture field. This work utilized the advantages of Internet of Things (IoT) and Fuzzy logic. The proposed work reduces the burden on the farmers and increases GDP of Indian economy.**

Keywords: Agriculture, Fuzzy logic, IoT , Water Management

I. INTRODUCTION

Agriculture [1] is a major source of living in India. The yield rate of the crops is related to various factors such as the supply of water, fertilizer and soil conditions. Day by day, the rate of farmers suffering from various factors occurring in the agriculture is increasing. This is a major problem in the countries like India where major occupation was farming. India is a major contributor in supply of food grains across the world.

In some villages, water can be supplied to the farming field from large distances through pipes and water tanks. The damage to pipes at any stage causes the limited supply of water which results to loss of yield. Similarly unregulated water supply from tanks and unexpected water from natural sources such as rainfall leads to excess supply of water to the farming fields. This results to the damage of the crops. Therefore there is a necessity to utilize the water in a proper way in agriculture lands. The recent technologies such as IoT and artificial intelligence are helpful to design and develop better methods for efficient management of water supply.

Revised Manuscript Received on January 30, 2020.
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The remaining sections of the work is presented as given below: section 2 illustrates the IoT and fuzzy logic- a branch of artificial intelligence, section 3 describes briefly the related work, section 4 describes the methodology and section 5 shows results and conclusion.

II. IOT AND FUZZY LOGIC

The Internet of Things (IoT)[2] is a platform to connect and communicate various devices and people around the globe. IoT helps to the farmer by providing more technological assistance through sensors and communication among the things to increase the productivity. Fuzzy logic [3][is a logic with many values from 0 to 1. It is a way a logic that mimics the thinking behavior of humans. This logic helps to deal with the imprecise data in a better way

III. RELATED WORK

Richard Charles et.al [4] presented studies on IoT solutions for animal monitoring and automation of irrigation. Ram Krishna Jha et.al [5] concentrated on Agriculture field monitoring with various IoT devices. They utilized the Arduino Microcontroller to implement the project and made an analysis on the collected data. Yemeserach Mekonnen et.al [6] proposed a method to utilize the resources such as water and fertilizers. They concentrated mainly on utilizing Photo-voltaic (PV) panel and IoT devices. Tarushi Wasson et.al [7] proposed IoT based agriculture system to observe and analyze the various conditions that occur in crop yield. Their method incorporates sensors and RFID technology.

Sneha Murmu et.al [8] reviewed different soft computing techniques for crop mapping which is essential for estimating crop water requirements. They revealed that in future techniques such as fuzzy systems, artificial neural networks and evolutionary algorithms plays an important role to solve the real world problems. Koushik Anand et.al [9] monitored and controlled the cultivated field through cell text messages and fuzzy logic. They considered the temperature, soil humidity and time duration to open the valves.

Sakharova Luydmila et.al [10] proposed a fuzzy model for comprehensive evaluation towards sustainability of the crop culture. They utilized weight parameters during the evaluation process. Mohd Azlan et.al [11]developed a fuzzy system to find the changes in temperature, humidity and illumination within the plants to determine the lighting intensity.

They employed VB software to carry out the simulation of fuzzy system. E.Neamatollahi et.al [12] proposed a fuzzy system for achieving the best cropping pattern in agriculture.

They considered minimizing amount of water and others as the main objectives. They concluded that fuzzy system is helpful in agricultural and horticultural sectors.

IV.METHODOLOGY

Farmers in some villages are utilizing the water through pipes which are connected from long distances. If any leakage occurs while water flowing through pipes, there is a chance for loss of water and decrease in production of crop. Therefore it is a critical issue to detect the leaking of water through pipes. Water can also be supplied to agriculture through the natural resources such as rainfall and from the farmer through pipes/pumps. Too much of water supply to the crop from the rainfall and from the farmer simultaneously leads to the damage of the crop yields and water wastage. Therefore it is another major challenge for balanced supply of water. Apart from these, the ignorance and innocence of the farmer can also lead to wastage of water supply. The proposed model overcomes the above challenges, increases the crop production in a cost effective way and ultimately leads to the growth of Indian economy.

The combination of Artificial Intelligence and IoT plays a vital role for efficient water management to increase the crop production. In this paper, The Fuzzy logic – a sub branch of Artificial Intelligence is applied to control the operation of motor and for balanced water supply. The IoT utilizes sensor information for leakage detection of the pipes, occurrence of rainfall and timely supply of water.

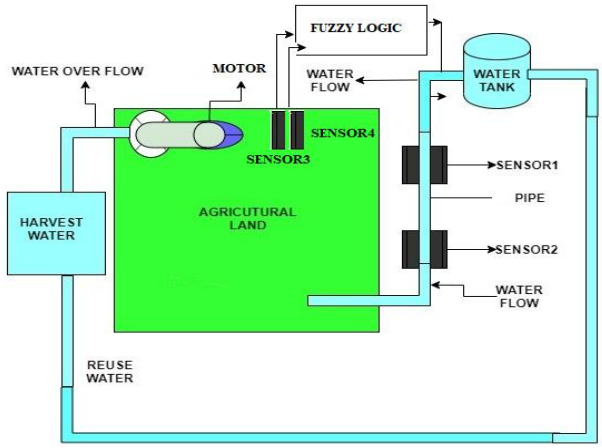

Figure 1: Block diagram of efficent water management system

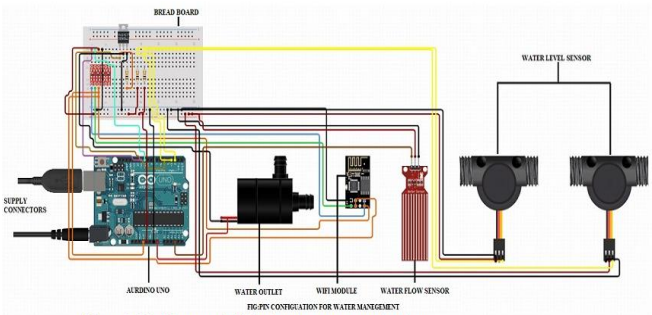

Figure 2: Pin diagram of Efficient water management system

Water flow sensors are placed uniformly throughout the pipe. If any leakage occurs while water flowing through pipes, sensor can detect the leakage/flow rate and update the locations through the Android Application. There is a necessity to predict the occurrence of a rainfall in a given location for to avoid too much of water supply and water wastage. This can be done with the help of GPS and Internet weather forecasting modules. Basing on the information of weather updates and water level in the field, the Fuzzy Logic controller controls the operation of the motor and maintains balanced supply of water. Finally the presence of excess of water in the field can be detected through IoT sensors and directed to the storage tanks. In the emergency situation, the storage can be further utilized. Components utilized in the design and development is presented in Table 1 with their description. The block and pin diagrams are shown in figures 1 and 2 respectively.

Table 1: Components and their description in the proposed work

Name of the Component	Description
ARDUINO UNO	The Arduino Uno is an open-source microcontroller board is equipped with sets of digital and analog input/output (I/O) pins
Water flow sensor YF-S201	This sensor is used to measure how much liquid has moved through it.
Wifi module ESP8266	The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller
Water level sensor Robodo SEN-18	**Level sensors** are used to detect the **level** of substances that can flow. This is used to determine the amount of materials within a closed container or the flow of **water** in open channels.
Water pump Micro DC 6-9V Submersible and Non Submersible *Mini Water Pump* DC Motor	An "electric mini **water pump**" depends on electricity for its power source and converts the electric energy into mechanical energy to provide required pressure to the **water.**

The fuzzy logic architecture used in the development is shown in figure 3. The membership functions for the input and output are shown figures 4,5 and 6.The rules base, surface view and fuzzy evaluation is shown in figures 7, 8 and 9.

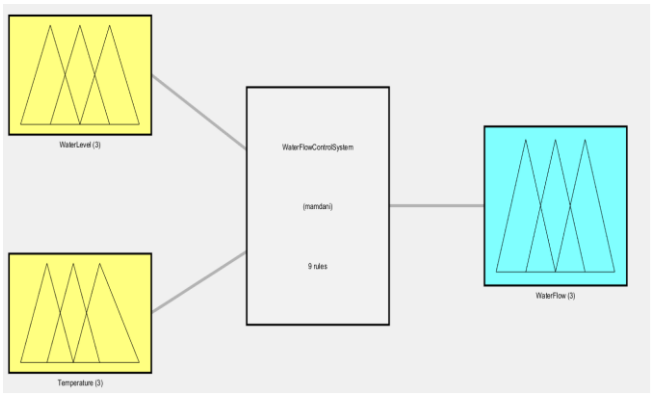

Figure 3: Fuzzy Architecture of Efficient water management system

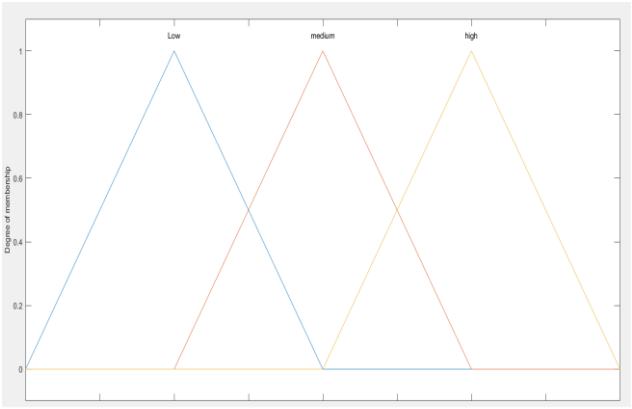

Figure 4: Membership function for the input - 'WaterLevel'

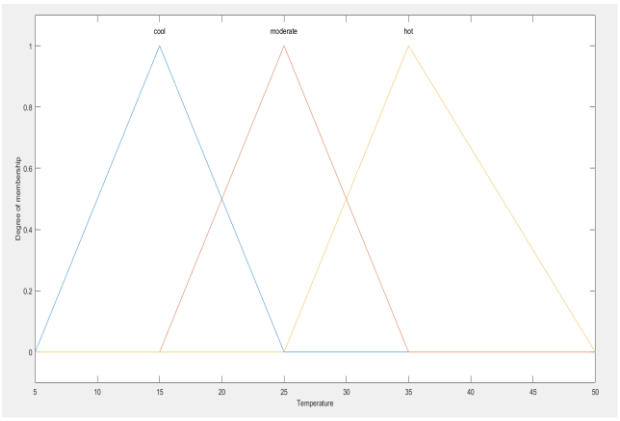

Figure 5: Membership function for the input - 'Temperature'

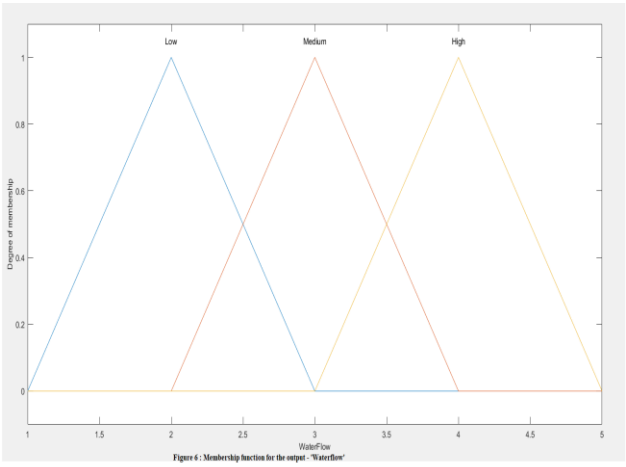

Figure 6 : Membership function for the output - 'Waterflow'

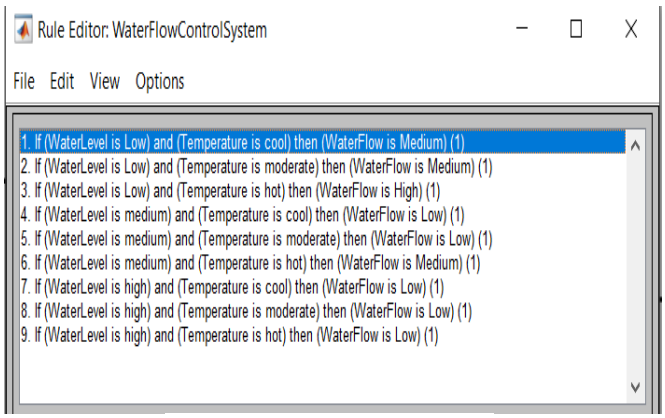

Figure 7 : Fuzzy rule base

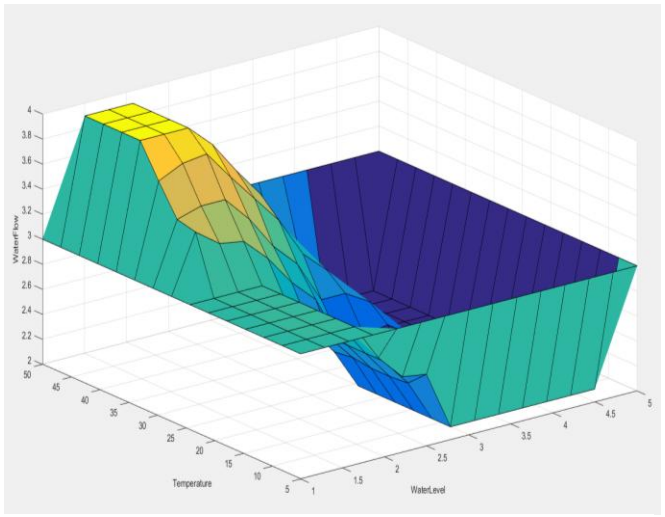

Figure 8 : Surface view of Efficeint water management system

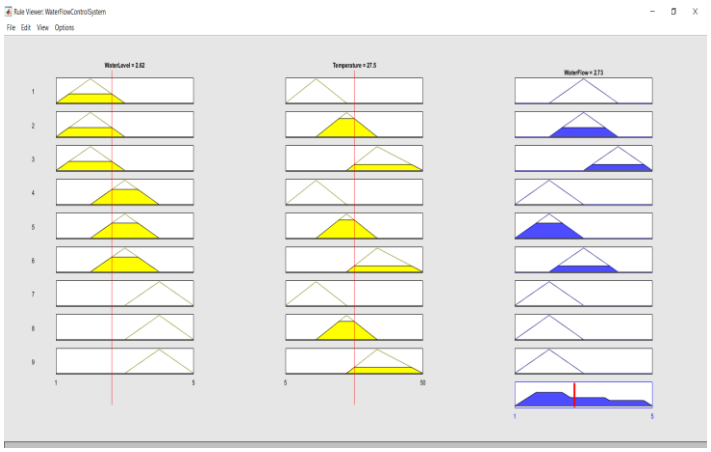

Figure 9 : Fuzzy rule evaluatio for a typical input

V.RESULTS AND CONCLUSION

Water is an essential requirement for cultivation of crops. The proposed method supplies water to the agriculture field based on IoT and Fuzzy logic in an efficient way. This technique solves the problems of leakage in water flowing through pipes using IoT and intelligently controls the water supply using fuzzy logic. This technique is an inexpensive process and helps in improving productivity of the crops and acts as assistance to increase the GDP of the country. The Table 2 illustrates the comparison view of existing technologies with the proposed work. In future, this technique can further be improved with usage of neural networks.

Table2: Comparison of proposed work with existing technologies

Technologies	**Water Overflow**	**Crop Yield**	**Water Storage**
Manually	More	Low	Low
IoT	Less	Medium	Moderate
IoT+Fuzzy Logic	Very Less	High	Very High

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